The Competition between Contour and Register Correspondence in Music-to-Language Perception: Evidence from Mandarin Child Songs

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1. Introduction

This study investigates the influence of music register and music contour on child perception of Mandarin child songs within the framework of Optimality Theory (Prince and Smolensky 1993). Mandarin is a tone language. The word meaning relies not only on segments but also on tones. When the words are sung, the tones disappear. The following are the research questions: (a) How does music register correspond with the perceived lyric register? (b) How does music contour correspond with the perceived lyric contour? (c) What is the interaction between contour and register correspondence?

This study establishes a lyric perception corpus. The following section introduces the major findings from the corpus.

2. The Corpus

The corpus collects the perception errors of sixteen Mandarin song from a four-year-old child, whose native language is Mandarin Chinese. The child was asked to say the lyrics she heard. She was also asked if she understand the lyrics she said.

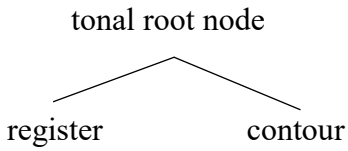
The influence of music melody was observed through the perception errors as explained in 2.1 and 2.2.

2.1 Language tone

There are four tones in Mandarin: namely, *yinping*, *yangping*, *shang*, and, *qu* in traditional terminology. According to Chao's (1930) five level tone mark, these tones can be categorized as 55, 35, 214, and 51 respectively. However, *shang* is pronounced as 21 by most people in Taiwan. Therefore, *shang* is changed into 21 in this study.

This study applies Bao's (1999:46) tone geometry to investigate the correspondence between music melody and lyrics. As shown in (1), tone root is the highest node of a tone which consists of two major components, namely contour and register.

(1) Tone geometry



As shown in (2), Hr stands for a high register tone while Lr stands for a low register tone. As for contours, l and h indicates level tones. hl is a falling tone and lh is a rising tone. For example, 35 (Hr, lh) is a high register rising tone.

(2) Mandarin tones

(Hr, h)	55
(Hr, lh)	35
(Lr, hl)	21
(Hr, hl)	51

2.2 Music melody

In this paper, music melody is represented in numbered musical notation. As shown in (3), the upper row shows musical notes and the lower row shows numerical notations.

(3)

Notes	Do	Re	Mi	Fa	So	La	Ti	Do
Notation	1	2	3	4	5	6	7	i

In order to analyze the register and contour correspondence between language and music, this paper regards music melody as *music tone* and categorizes music melody into two components, which are register and contour. This paper transfers the definite music pitch into a flexible concept, in which music register is decided by the range of a song. Since different songs have different ranges, the music register is flexible. For instance, if the song ranges from *1* to *i*, then *4* belongs to low register. However, when the song ranges from *1* to *5*, then *4* belongs to high register.

Music contour refers to the correspondence between syllable and music note. When one music note matches one syllable, then the music contour is level. If two notes whose shape is rising matches one syllable, then the music contour is rising. If two notes whose shape is falling matches one syllable, then the music contour is falling.

As shown in (4), *6* is a high register level tone while *12* is a low register rising tone.

(4) Music tone (Song range: 1 to 6)

(Hr, h) (Hr, l)	6, 5, 4
(Hr, lh)	45, 46, 56
(Hr, hl)	65, 64, 54
(Lr, h) (Lr, l)	3, 2, 1
(Lr, lh)	12, 13, 23
(Lr, hl)	32, 31, 21

2.3 The register correspondence between language and music

The register correspondence between language and music can been seen from lyric perception errors. As shown in (5), the original lyric is [tɕjao21 tu51], 'angle' but the child misperceives it as an unknown phrase, [tɕjao51 tu51]. This is because the music register of the first syllable is high while the tone register of the first syllable is low. As a result, the child misperceives it as a high register tone.

(5) also shows that recognition of a phrase is not the priority to child perception. As shown in (5), the original lyric is [tɕjao21 tu51], *angle*, which is a recognizable phrase to the child. However, she still chooses [tɕjao51 tu51] as the perceived form, whose register corresponds with the music register. Nevertheless, the meaning of the perceived form is unknown to her.

(5)

	Music tone	**Original lyric**		**Perception**
IPA Gloss		[tɕjao21 tu51] angle	→	[tɕjao51 tu51] *meaning unknown*
High register	—— ——	＼		＼ ＼
Low register		＼		

The following example also shows how music register influences child perception of lyrics. As shown in (6), the music tone is a low register tone so the child perceives the lyric as a low register tone regardless of the fact that the original lyric is a high register tone.

(6)

	Music tone	**Original lyric**		**Perception**
IPA Gloss		[k^{h}ao51] keep near to	→	[p^{h}ao21] run
High register		＼		
Low register	——			＼

2.4 The contour correspondence between language and music

The music contour also has influence on child lyric perception. As shown in (7), the original lyric is [meɪ51], *sister*. However, it is perceived as [peɪ55], *cup*. It is because of the contour correspondence between language and music. The music contour is level so the child perceives the lyric as a level tone, which is different from the original lyrics that is a falling tone. Both the original lyric, [meɪ51] *sister*, and the perceived lyrics, [peɪ55] *cup*, are familiar to the child. Therefore, it is not recognition of a phrase that decides the perceived form. Additionally, the music tone, the original lyric, and the perceived form are all high register tones so register does not influence lyric perception here.

(7) also shows that register has stronger influence than segment. The child perceives [meɪ51] as [peɪ55] in order to match the music contour. However, the onset of [meɪ51] is changed into [p] and the preservation of segment is sacrificed.

(7)

	Music tone	**Original lyric**		**Perception**
IPA Gloss		[meɪ51] sister	→	[peɪ55] cup
High register	——	＼		——
Low register				

(8) is another example that demonstrates how music contour influences lyric perception. As exemplified in (8), the music contour is level so the child perceives the lyric as a level tone, [ta55]. Furthermore, the original lyric and the perceived form are both familiar to the child and both of them are high register tones. Therefore, music register and familiarity of the phrase is not influential here. Contour correspondence is the only reason why the child misperceives the lyric.

(8)

	Music tone	**Original lyric**		**Perception**
IPA Gloss		[ta51] big	→	[ta55] build
High register	——	＼		——
Low register				

2.5 The competition between contour and register correspondence

2.3 and 2.4 discuss the influence of music register and contour on lyric perception respectively. This section investigates the competition between contour and register correspondence and find out which one has stronger influence on child lyric perception. As shown in (9), the first syllable of the original lyric, [ji21], is a low register tone, which corresponds with the music register. Instead of perceiving a low register tone, the child perceives the first syllable as a high register tone, [jin55], whose contour correspond with the level music contour. This shows that music contour has stronger influence on child perception than music register. Both [ji21 weɪ35] 'suppose' and [jin55 weɪ51] 'because' are recognizable to the child, so lyric perception is not influenced by familiarity of the lyrics in this case.

(9)

	Music tone	**Original lyric**		**Perception**
IPA Gloss		[ji21 weɪ35] suppose	→	[jin55 weɪ51] because
High register		／		—— ＼
Low register	—— ——	＼		

(10) is another example showing the stronger influence of music contour. The second syllable of the original lyric is a low register tone, which correspond with the music register. However, the child still perceives it as a high register tone, whose contour corresponds with the music contour.

(10)

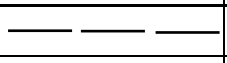
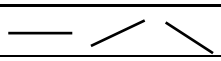
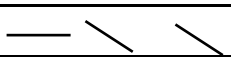
	Music melody	**Original lyric**		**Perception**
IPA Gloss		[jao51 tɕin21] important	→	[jao35 tɕin55] *meaning unknown*
High register		＼		／ ——
Low register	—— ——	＼		

2.6 Competition between familiarity of the lyrics and segment preservation

Section 2.3 to 2.5 have mentioned the interaction between music register correspondence, music contour correspondence, and child familiarity of the lyrics. In order to find out the complete Optimality Theory constraint ranking, this section discusses the competition between familiarity and segment preservation. As shown in (11), the music-to-language correspondence of the original lyrics and the perceived form is the same. In other words, the music melody, original lyrics, and perceived form are all high register tones. As for contour correspondence, the second and third syllables of the original lyrics and the perceived form do not correspond with the music contour. Therefore, music melody correspondence is not the factor that lead to misperception. Instead, the interaction between familiarity of the lyrics and segment preservation reveals how the child perceives lyrics.

A shown in (11), [la55 pa35 ta51], which means *raise (a child)*, is not recognizable to the child. As a result, she misperceives it as [la55 tao51 ta51], which is interpreted as *pull (the child) to grow up.* Nevertheless, the onset of the second syllable is changed from [p] to [t]. This indicates familiarity of a phrase has stronger influence on child lyric perception.

(11)

	Music melody	**Original lyric**		**Perception**
IPA Gloss		[la55 pa35 ta51] raise grow-up *unrecognizable to the child*	→	[la55 tao51 ta51] pull to grow-up
High register				
Low register				

3. Optimality theory analysis

This paper offers an optimality theory (Prince and Smolensky 1993) analysis of the child perception of Mandarin songs. As mentioned in 2.3, music register influence child perception of lyrics. The relevant constraint is ID-REG, which is a faithfulness constraint. In this study, faithfulness constraint demands that output and the reference output (RO) be the same. Reference output is the child's output form when reading lyrics.

(12) ID-REG: Assign one violation mark for every lyric tone whose register is not the same as the music register.

Section 2.3 also mentioned that register correspondence between language and music is more important than child recognition of the lyrics. In other words, the child may select an unknown word in order to make lyric register faithful to music register. The relevant constraint is shown in (13). The interaction between constraint (12) and (13) is shown in tableau (14).

(13) Familiarity: Assigns one violation mark for every phrase that is not recognizable to the child.

As shown in tableau (14), both of the music tones are high register tones. The lyrics tones of (14b) are a low register tone followed by a high register tone. (14b) is ruled out because its low register tone violates ID-REG, which ranks high. (14a) violates Familiarity but is still chosen as the optimal output because Familiarity ranks low. The segments and contours of the syllables of (14a) and (14b) are the same. Therefore, in tableau (14), contour and segment in music-to-language correspondence are not influential.

(14) Reference output:

Lyric segment： [tɕjao tu]

Music melody： 4 (Hr, l) 5 (Hr, l)

		ID-REG	Familiarity
☞a. [tɕjao tu] 51 51	*unknown*		*
b. [tɕjao tu] 21 51	‘angle’	*!	

The partial constraint ranking is shown in (15).

(15) ID-REG >> Familiarity

The following data discuss the influence of music contour on lyric perception. The relevant constraint is ID-CTR as defined in (16).

(16) ID-CTR: Assign one violation mark for every lyric tone whose contour is not the same as the music contour.

As mentioned in 2.4, the output segment may change in order to make lyric contour faithful to music contour. The segment faithfulness constraint is shown in (17).

(17) Seg-Faith: Assigns one violation mark for every output segment that is not the same as the corresponding segment in the reference output.

Tableau (18) shows the interaction between ID-CTR and Seg-Faith. (18b) is a falling tone, which does not correspond with the music contour. Therefore, (18b) incurs a fatal violation of ID-CTR and is ruled out. The segment of (18a) is different from the reference output but is still chosen as the optimal output. This shows that the child matches the lyric contour with the music contour in sacrifice of segment faithfulness. The lyric registers of (18a) and (18b) are both high register tones. Moreover, [peɪ], 'cup' and [meɪ], 'sister' are both recognizable the child. Therefore, constraint ID-REG and Familiarity have no effect on the selection of the output.

(18) Reference output:
Lyric segment： [meɪ]
Music melody： 6 (Hr, l]

	ID-CTR	Seg-Faith
☞a. [peɪ] 'cup' 55		*
b. [meɪ] 'sister' 51	*!	

The partial constraint so far is shown in (19).

(19) ID-REG >> Familiarity
ID-CTR >> Seg-Faith

The previous tableaux show that music register and music contour are both influential to child perception of lyrics. The following data examines the competition between register and contour. Tableau (20) shows the constraint interaction between ID-CTR and ID-REG. Both of the music tones are low register tones. (20b) violates ID-CTR twice because both of the lyric tones are falling tones. Since ID-CTR ranks high and (20b) incurs more violation mark than (20a), (20b) is eliminated. (20a) violate ID-REG more time than (20b). However, ID-REG ranks low so (20a) is still chosen as the optimal output.

(20) Reference output:

Lyric segment： [jao tɕin]

Music melody： 2 (Lr, l) 1 (Lr, l)

	ID-CTR	ID-REG
☞a. [jao tɕin] *unkonwn* 35 55	*	**
b. [jao tɕin] 'important' 51 21	**!	*

The partial constraint is shown in (21).

(21) ID-CTR >> ID-REG >> Familiarity; Seg-Faith

As shown in (22), the ranking between Familiarity and Seg-Faith is unknown so far. The following tableau reveals the ranking between them. (22a) violates Seg-Faith twice but is still chosen as the optimal output. It is because [la55 tao51 ta51] is a recognizable phrase to the child. The child does not choose the unknown phrase in (22b) even though every segment is preserved from the original lyrics.

(22) Reference output:

Lyric segment： [la pa ta]

Music melody：

	Familiarity	Seg-Faith
☞ a. [la tao ta] 'raise' 55 51 51		**
b. [la pa ta] *unknown* 55 35 51	*!	

The complete constraint is shown in (23).

(23) ID-CTR >> ID-REG >> Familiarity >> Seg-Faith

4. Conclusion

This paper examines the music-to-language perception grammar and discusses the competition between music contour and music register and other factors that influences child perception of lyrics. It is found that lyric perception is mainly affected by music melody. In particular, music contour has stronger influence than music register. In other words, the child may perceive the lyrics according to the contour correspondence

between language and music and sacrifice register correspondence. As previously shown in (23), register correspondence ranks higher than Familiarity. This suggests that the child may choose an unrecognizable phrase in order to satisfy the register correspondence. Segment faithfulness is at the bottom of the ranking, which implies that Segment faithfulness is least important to child perception of lyrics.

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